

ARC '16

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<http://dx.doi.org/10.5339/qfarc.2016.EEPP3404>

Life Cycle Assessment of Tall Buildings in Qatar, A focus on Construction Materials Use and Techniques

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Buildings represent one of the most significant sources of negative impacts to the natural ecosystems on which Qatar's inhabitants health and environmental quality depend. The market has identified Qatar as one of the busiest construction areas in the world (Ibrahim 2011), While rapid economic development, population growth, and construction boom are positive indicators of growth, they may also present issues related to the negative impact on the socio-environmental components of cities. Such is the case of the Gulf Cooperation Council (GCC) countries where increasing economic prosperity has led to a surge in tall building construction and a sense of competition to erect the tallest skyscrapers in the world (Mahgoub and Abarra 2012).

While tall buildings are a source of national pride and cultural identity enabled by economic prosperity, they pose several challenges to integrate with the urban fabric of the city while also having a tremendous environmental impact. Tall buildings are especially massive consumers of energy (Ali and Armstrong 2008). They are the dominant elements in urban architecture due to their scale and purpose, and should be the focus of sustainable design. With large number of towers constructed and to be constructed in Al Dafna and West Bay areas of Doha, these buildings affect different aspects of the built and urban environment, i.e., city image, traffic, urban spaces and physical conform. Therefore, more architectural design strategies have to be planned well ahead in order to tackle the issues of sustainability and adaptability to climate change and to foster sustainable built environment in the state of Qatar.

With Qatar slated to host a 'zero carbon' World Cup in 2022, Qatar Green Building Council (QGBC) has set up a group to foster green infrastructure as a national resource. Qatar is utilizing Leadership in Energy and Environmental Design (LEED) and the Global/Qatar Sustainability Assessment System (GSAS/QSAS) to this end. Furthermore, shortages in

Cite this article as: Fadli F, Dacanay T, Moen C, Guest J, Bahrami P. (2016). Life Cycle Assessment of Tall Buildings in Qatar, A focus on Construction Materials Use and Techniques. Qatar Foundation Annual Research Conference Proceedings 2016: EEPP3404 <http://dx.doi.org/10.5339/qfarc.2016.EEPP3404>.

raw materials between 2013 and 2017 are expected to challenge the construction sector, as the period is expected to be the peak for the sector. Therefore, the sector will have to bridge the gap during this period by mutual agreements with the companies in Saudi Arabia and the UAE (QCB 2012).

The objectives of this paper are as follows: 1- to Identify sustainability metrics for tall buildings with focus on construction materials and methods used in Qatar; 2- Explore existing literature and identify analogies in optimization consistent with design variables; 3- to examine sustainability of construction materials used in Qatar by utilizing software which is based on currently available databases to perform life cycle assessment.

To meet the objectivess described above, the currently available software platforms to perform life cycle analysis of building materials were explored. A commercial software, SimaPro, which utilizes the environmental impact database Ecoinvent, was chosen for its flexibility in defining custom mix designs for concrete, as well as database information on steel and many other building materials. With SimaPro, a sustainability model for concrete and steel was developed which reflects the environmental implications of manufacture of materials in Qatar as appropriate. Quantitative results from the model for the sustainability of constituents of building materials were extracted, to form the basis of sustainability metrics in the forthcoming tall building topology optimization protocol.

Furthermore, Blanco-Carrasco et al (2010) outline reduced use of Portland cement, increased use of alternate cementitious materials, and reduced water use to improve the sustainability of the concrete industry in Qatar. Using structural models and the SimaPro model, ultra-high performance concrete was explored as a potential solution for all these problems, to be applied in the gravity/lateral structural components of Qatar tall buildings. In addition to identifying a novel material which fits well with the current tall building designs of the region, the process of examining the structural and environmental improvements from using ultra-high performance concrete has resulted in the formation of a procedure to compare multiple materials used in Qatar.

This paper is a result of a funded research project by QNRF, entitled “Multi-Objective Tall Building Topologies – Optimizing for Structural Performance, Economy, and Sustainability” and a jointly collaboration between researchers from Qatar University, Virginia Tech, Johns Hopkins University, Optim Design Inc, and MZ & Partners.

Acknowledgements

“This research/publication was made possible by a National Priority Research Program NPRP award [NPRP- 7 - 1518 - 2 – 549] from the Qatar National Research Fund (a member of The Qatar Foundation). The statements made herein are solely the responsibility of the author(s).”